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PCT / IN05 / 00042
10 FEBRUARY 2005 (10.02.05)

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CP-2, SECTOR-V,
SALT LAKE CITY,
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TO ALL TO WHOM THESE PRESENTS SHALL COME:

15th March, 2005.

THIS IS TO CERTIFY THAT ANNEXED HERETO IS A TRUE COPY OF *PATENT APPLICATION NO. 57/KOL/2004 FILED ON 11/02/2004* FROM THE RECORDS OF THE PATENT OFFICE OF THOSE PAPERS OF THE BELOW IDENTIFIED INTERNATIONAL PATENT APPLICATION FILED AT RECEIVING OFFICE, INDIA THAT MET THE REQUIREMENTS TO BE GRANTED A DOCUMENT UNDER SECTION 147 OF THE PATENTS ACT, 1970.

INTERNATIONAL APPLICATION NUMBER: PCT/IN05/00042.

INTERNATIONAL FILING DATE: 10TH FEBRUARY, 2005.

THE PATENT OFFICE
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(Dr. P. C. Chakraborti)
Certifying Officer

IPC7: C21C7/00

FORM-1

(To be filed in Triplicate)

THE PATENTS ACT, 1970

Metallurgy

PCT/IN05/00042

(39 of 1970)

APPLICATION FOR GRANT OF A PATENT

[See Sections 5(2) 7, 54 and 135]

1. We THE TATA IRON & STEEL COMPANY LIMITED, Research and Development Division Jamshedpur 831001 India, an Indian Company.

2. hereby declare-

(a) that ~~I am~~ / We are in possessin of an Invention titled

Title: A CORED WIRE INJECTION PROCESS IN STEEL MELTS

(b) that the Provisional / ~~Complete~~ Specification relating to this invention filed with this application.

(c) that there is no lawful ground of objection to the grant of a patent to me / us.

3. Further declare that the inventor(s) for the said invention is / are :

Surname first and then name of inventor/s

1. SANYAL SARBENDU,
2. CHANDRA SANJAY,

C/o. The Tata Iron & Steel Company Limited Research and Development Division Jamshedpur 831001 India, Both are Indian nationals.

4. I/We, claim the priority from the application(s) filed in convention countries, particulars of which are as follows :

NA

5. I/We state that the said invention is an improvement in or modification of the invention the particulars of which are as follows and of which I/We are the application/patentee:

NA

6. I / We state that the application is divided out of my/our application, the particulars of which are given below and pray that this application be deemed to have been filed on NA under section 16 of the act.

7. That I am / We are the assignee of the true and first inventors.

8. That my / our address for service in India is as follows :

L S DAVAR & CO.,
Monalisa, Flats IB & IC, 17, Camac Street,
Kolkata-700 017.
Phones : 247-3996, 247-5918, 280-5536
Fax No. : 91-33-247-5886, 240-6292
91-11-646-4443

9. Following declaration was given by the inventor(s) or applicant(s) in the convention country :
I / We the true and first inventors for this invention or the applicant(s) in the convention country declare that the applicant(s) herein is / are my / our assignee or legal representative.

Signature of the true and first Inventor/s or Applicant In the convenstion country with date, name to be given below Signature

SANYAL SARBENDU

CHANDRA SANJAY

10. That to the best of my / our knowledge, information and belief the fact and matters stated herein are correct and that there is no lawful ground of objection to the grant of patent to me / us on this application.

11. Following are the attachment with application :

(a) Provisional/Complete specification (3 copies).

(b) Drawings 2 (Sheets) 3 copies.

(c) Priority document/s NA

(d) Statement and undertaking on Form 3 in dupl.

(e) Form 5. NA

(f) Power of Authority. To Follow

(g)

(h) 3000/-

(i) Fee Rs. 1,500/- /Rs. 5,000/- in cheque / bank draft. bearing No.....date..... on.....Bank.

To be Signed by applicant or authorised patent agent

I/We request that a patent may be granted to me/us for the said invention.

Dated this 11th day of February 2004

Signature ( )

OF L-S-DAVAR & CO.
APPLICANTS' AGENT

To
The Controller of Patents
The Patent Office
at Kolkata

FORM – 2

THE PATENTS ACT, 1970

(39 of 1970)

PROVISIONAL/COMPLETE

SPECIFICATION

SECTION 10

TITLE

A CORED WIRE INJECTION PROCESS IN STEEL MELTS

APPLICANT

THE TATA IRON & STEEL COMPANY LIMITED,
Research and Development Division
Jamshedpur 831001 India, an Indian Company.

The following specification particularly describes the nature of the invention and the manner in which it is to be performed

FIELD OF THE INVENTION

The present invention relates to a cored wire injection process in steel melts. In particular, it relates to the dimension of a cored wire used in steel plants to inject fluxes and alloying additions in molten steel baths.

The objectives of such additions are either to refine the steel further or to adjust the composition to meet the chemistry for the final applications of the steel. This invention aimed at the increase of the yield of the powder in the steel bath and thereby reduces consumption.

BACKGROUND INFORMATION

Steelmaking is essentially an oxidation process where the impurities (i.e. the undesirable elements) of the molten metal (either pig iron or melted scrap) are preferentially oxidized to join the slag along with fluxes. Some amount of oxygen and the inclusions, like alumina formed due to subsequent de-oxidation process, remain in the steel. These oxygen and inclusions not only create operational problems during further processing of the steel in continuous casting and rolling but also are mostly detrimental to the product quality. The major challenge to the steel plant operators is to reduce their content below a certain level.

The use of calcium is beneficial in this direction. However, the introduction of it in liquid steel bath is very difficult due

to its low density and low vapour pressure. The advent of cored wire injection technology and the development of calcium bearing powders like calcium-silicide, calcium-iron etc have enabled the steel plant operators to introduce the calcium in steel baths.

The yield of calcium in the cored wire injection process is at the most 30% and sometimes it becomes as low as 2% depending on grades of steel processed and the operating conditions.

The loss of calcium occurs mainly in three modes:

i) Some amount is vapourised and lost to the atmosphere in unreacted condition.

ii) Some react with ladle top slag and lost.

iii) Some react with the dissolved oxygen and inclusion present in the steel and join the slag.

When the steel plants are desperately looking for cost reduction options, there exists a need for an improvement in the yield of calcium. An increase of 10% in the yield of calcium should lead to big savings.

SUMMARY OF THE INVENTION

The main object of the present invention therefore, is to increase the yield of calcium in a cored wire injection process.

It has been observed that the utilization of calcium is maximum when the calcium powder is released from cored wire very close to the bottom of the ladle so that the losses through the first two modes mentioned above can be kept to a minimum. The key factors which determine the zone of release of the powder are the

speed of injection and the dimensions of the cored wire keeping the grade of steel processed, treatment temperature and the powder and sheath properties constant.

The main object of the invention is achieved by controlling the zone of release of the powder and thereby the yield of calcium by changing the dimensions of the cored wire and the speed of injection. The diameter of the cored wire and the thickness of the mild steel sheath are varied along with a suitable speed of injection to ensure that the powder is released very close to the bottom.

The variation in the diameter of wire for a 140 ton ladle having 3 meter bath depth is from 13 mm to 18 mm and the variation of sheath thickness is from 0.4 mm to 0.8 mm. The exact combination of the diameter, sheath thickness and the speed depends on the grade of steel processed and the treatment temperature.

The invention will now be described with the help of the accompanying drawings.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

Figure 1 shows optimization of travelled distance with different wire dimensions.

Figure 2 shows an improvement in the yield of calcium;

Figure 3 shows the reduction in consumption of calcium powder.

DETAILED DESCRIPTION OF THE INVENTION

After the steel is made in the primary steelmaking vessel, the liquid steel is carried in a ladle to the secondary treatment unit. The main purpose of the secondary treatment unit is to further refine the steel, adjust the bath temperature and chemistry to suit the demand of the next processing unit i.e. continuous casting unit. The presence of dissolved oxygen and inclusions in the liquid steel poses problem to the smooth operation of continuous casting and also deteriorate the product quality. The calcium treatment of the steel, thus, becomes esssential to control the dissolved oxygen level as well as the shape and characteristics of the inclusions. The liquid steel is treated with the calcium bearing cored wires in the secondary processing units.

The variety of steel grades, a steel shop produces, requires varying specification of the cored wire to exploit maximum benefit from it. It has been already established that, if the calcium bearing power is released at the maximum possible depth of the bath (i.e. close to the ladle bottom), the maximum benefit can be obtained.

An elaborate mathematical model has been developed to predict distance travelled by a cored wire before releasing the filling powder when injected in a molten bath. Based on the model results and the experimental results discussed in the "experimental work" section, it is clear that the most common calcium bearing cored wires of 13 mm diameter with Ø.4 mm sheath thickness is not suitable for steel grades having high liquidus temperature and/or high treatment temperatures in 140 ton capacity ladle with around 3 meter bath depth. The best wire for such applications should have 18 mm diamter and Ø.8 mm sheath thickness and the injection speed should be around 110 m/min.

Figure 1 has been presented, as an example, to visualize the effect of different wire dimensions and the injection speed when injected in a liquid steel bath at 1630 °C having the bath liquidus temperature of 1525 °C. It is clearly evident from the above figure that the wires like 13 mm diameter – Ø.6 mm sheath thickness, 16 mm diameter–Ø.6 mm sheath thickness, 13 mm diameter–Ø.8 mm sheath thickness and 18 mm diaamter–Ø.8 mm sheath thickness reach the bottom of the ladle before releasing the powder. The"travelled distance" mentioned in the figure 1 is the distance travelled by the wire before releasing the powder. Thus, the diameter of the wire should be more than 13 mm and the sheath thickness should be more than Ø.4 mm to suit the treatment temperature and the grade of steel to be processed.

EXPERIMENTAL WORK

Trials have been conducted in a steel plant result of which has been shown above. The wire used was the conventional calcium-iron powder bearing wire of 13 mm diameter with 0.4 mm sheath thickness and the injection was done at a steel bath temperature of 1630 °C when the liquidus of bath was 1525 °C. The reduction of injection speed (V) from 240 m/min to 150 m/min has shown an improvement in the yield of calcium as shown in figure 2.

The next phase of trial was conducted using 16 mm calcium-iron powder bearing wire having 0.4 mm sheath thickness. The further improvement in the yield is evident from the figure 2. The reduction in powder consumption to achieve the same level of treatment efficiency is shown in figure 3.

Dated this 11th day of FEBRUARY, 2004

(B. B. SEN)
of L. S. DAVAR & CO
Applicants' Agent